

What is claimed is:

1 1. A multiplexer comprising:
2 a first switching fabric comprising a plurality of inputs
3 and a plurality of outputs;
4 a plurality of transponders, one transponder of the
5 plurality of transponders per output of the plurality of
6 outputs of the first switching fabric, each transponder of the
7 plurality of transponders comprising an input and an output,
8 the input of said each transponder connected to the output of
9 the first switching fabric associated with said each
10 transponder;
11 a plurality of output switches, one output switch of the
12 plurality of output switches per transponder of the plurality
13 of transponders, each output switch of the plurality of output
14 switches comprising a first input, a second input, and an
15 output, the first input of said each output switch being
16 coupled to the output of the transponder associated with said
17 each output switch;
18 a link transmit interface comprising a plurality of inputs
19 and an output, one input of the plurality of inputs of the link
20 transmit interface per output switch of the plurality of output
21 switches, each input of the plurality of inputs of the link

22 transmit interface coupled to the output of the output switch
 23 associated with said each input of the link transmit interface,
 24 the output of the link transmit interface being capable of
 25 coupling channels appearing on the inputs of the link transmit
 26 interface to an optical transmission link; and

27 a link receive interface comprising an input and a
 28 plurality of outputs, one output of the plurality of outputs of
 29 the link receive interface per output switch of the plurality
 30 of output switches, each output of the plurality of outputs of
 31 the link receive interface coupled to the second input of the
 32 output switch associated with said each output of the link
 33 receive interface, the link receive interface being capable of
 34 coupling channels appearing on the input of the link receive
 35 interface to the outputs of the link receive interface.

1 2. A multiplexer according to claim 1, wherein the first
 2 switching fabric is a spatial switching fabric.

1 3. A multiplexer according to claim 1, wherein:
 2 the first switching fabric is an optical spatial switching
 3 fabric capable of connecting any of the inputs of the plurality
 4 of inputs of the first switching fabric to any of the outputs
 5 of the plurality of outputs of the first switching fabric;

6 each of the transponders comprises a fixed wavelength
7 laser;

8 the link receive interface is a dense wavelength division
9 multiplexing fiber-optic interface coupling discrete wavelength
10 channels appearing on the input of the link receive interface
11 to the outputs of the link receive interface, one wavelength
12 channel per output of the link receive interface; and

13 the link transmit interface is a dense wavelength division
14 multiplexing interface.

1 4. A multiplexer according to claim 3, further
2 comprising a computer coupled to the first switching fabric and
3 the output switches for configuring the output switches to
4 select which of the channels appearing on the input of the link
5 receive interface are coupled to the optical transmission link,
6 and for configuring the first switching fabric to select paths
7 of signals appearing at the inputs of the first switching
8 fabric through the first switching fabric.

1 5. A multiplexer comprising:
2 a first switching means comprising means for receiving a
3 plurality of channels, a plurality of means for outputting

4 channels, and means for routing channels from the means for
5 receiving to the means for outputting;

6 a plurality of transponder means, one transponder means
7 per means for outputting, each transponder means for receiving
8 a channel from the means for outputting associated with said
9 each transponder means, and for converting the channel received
10 by said each transponder means into a fixed-wavelength channel;

11 a plurality of second switching means, one second
12 switching means per transponder means, each second switching
13 means comprising a first input, a second input, and an output,
14 said each second switching means capable of switching the first
15 or second input of said each second switching means to the
16 output of said second switching means, the first input of said
17 each second switching means coupled to the transponder means
18 associated with said each second switching means so as to
19 receive the converted fixed-wavelength channel of the
20 transponder means associated we said each second switching
21 means;

22 a link transmit interface for receiving channels appearing
23 on the outputs of the second switching means and coupling the
24 channels appearing on the outputs of the second switching means
25 to a first dense wavelength multiplexed fiber-optic link; and

26 a link receive interface for receiving channels from a
27 second dense wavelength division multiplexed fiber-optic link
28 and coupling the channels received from the second fiber-optic
29 link into second inputs of the plurality of second switching
30 means, one channel received from the second fiber-optic link
31 per second switching means.

1 6. A multiplexer according to claim 5, further
2 comprising computer means coupled to the first switching means
3 and the plurality of second switching means for configuring the
4 plurality of second switching means to select which of the
5 channels received from the second fiber-optic link are coupled
6 to the first fiber-optic link, and for configuring the first
7 switching means to select paths of channels appearing at the
8 means for receiving of the first switching means through the
9 first switching means.

1 7. A multiplexer comprising:
2 a first switching fabric comprising a plurality of inputs
3 and a plurality of outputs;
4 a plurality of receivers, one receiver of the plurality of
5 receivers per output of the plurality of outputs of the first
6 switching fabric, each receiver of the plurality of receivers

7 comprising an input coupled to the output of the first
8 switching fabric associated with said each receiver;

9 a plurality of input switches, one input switch of the
10 plurality of input switches per input of the plurality of
11 inputs of the first switching fabric, each input switch of the
12 plurality of input switches comprising an input, a first
13 output, and a second output, the first output of said each
14 input switch being coupled to the input of the first switching
15 fabric associated with said each input switch;

16 a link receive interface comprising an input and a
17 plurality of outputs, one output of the plurality of outputs of
18 the link receive interface per input switch of the plurality of
19 input switches, each output of the plurality of outputs of the
20 link receive interface coupled to the input of the input switch
21 associated with said each output of the link receive interface,
22 the link receive interface being capable of coupling channels
23 appearing on the input of the link receive interface to the
24 outputs of the link receive interface; and

25 a link transmit interface comprising a plurality of inputs
26 and an output, one input of the plurality of inputs of the link
27 transmit interface per input switch of the plurality of input
28 switches, each input of the plurality of inputs of the link

1 10. A multiplexer according to claim 9, further
2 comprising a computer coupled to the first switching fabric and
3 the input switches for configuring the first switching fabric
4 and the input switches to control paths of the discrete
5 wavelength channels through the multiplexer.

1 11. A multiplexer comprising:

2 a first switching means comprising a plurality of means
3 for receiving wavelength channels, a plurality of means for
4 outputting wavelength channels, and means for routing channels
5 from the means for receiving to the means for outputting;

6 a plurality of wavelength channel receivers for converting
7 wavelength channels into electronic data flows, one receiver
8 per means for outputting, each receiver coupled to the means
9 for outputting associated with said each receiver;

10 a plurality of second switching means, one second
11 switching means per means for receiving, each second switching
12 means comprising an input, a first output, and a second output,
13 said each second switching means being capable of switching the
14 input of said each second switching means to the first or the
15 second output of said each second switching means, the first
16 output of said each second switching means coupled to the input

17 of the first switching means associated with said each second
18 switching means;

19 a link receive interface for receiving wavelength channels
20 from a second dense wavelength division multiplexed fiber-optic
21 link and coupling the wavelength channels received from the
22 second fiber-optic link into the inputs of the second switching
23 means, one wavelength channel received from the second fiber-
24 optic link per second switching means;

25 a link transmit interface for receiving wavelength
26 channels appearing on the second outputs of the second
27 switching means and coupling the channels appearing on the
28 second outputs of the second switching means into a first dense
29 wavelength multiplexed fiber-optic link.

1 12. A multiplexer according to claim 11, further
2 comprising a computer coupled to the first switching means and
3 the plurality of second switching means for configuring the
4 first switching means and the second switching means to control
5 paths of the wavelength channels through the multiplexer.

1 13. A multiplexer comprising:
2 a first switching fabric comprising a plurality of inputs
3 and a plurality of outputs;

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4 a plurality of transponders, each transponder of the
5 plurality of transponders comprising an input and an output,
6 the input of said each transponder coupled to a different one
7 of the outputs of the plurality of outputs of the first
8 switching fabric;

9 a plurality of output switches, one output switch of the
10 plurality of output switches per transponder of the plurality
11 of transponders, each output switch of the plurality of output
12 switches comprising a first input, a second input, and an
13 output, the first input of said each output switch being
14 coupled to the output of the transponder associated with said
15 each output switch;

16 a link transmit interface comprising a plurality of inputs
17 and an output, one input of the plurality of inputs of the link
18 transmit interface per output switch of the plurality of output
19 switches, each input of the plurality of inputs of the link
20 transmit interface coupled to the output of the output switch
21 associated with said each input of the link transmit interface,
22 the output of the link transmit interface coupling channels
23 appearing on the inputs of the link transmit interface to an
24 optical transmission link;

25 a plurality of input switches, one input switch of the
26 plurality of input switches per output switch of the plurality
27 of output switches, each input switch of the plurality of input
28 switches comprising an input, a first output, and a second
29 output, the second output of said each input switch coupled to
30 the second input of the output switch associated with said each
31 input switch;

32 a link receive interface comprising an input and a
33 plurality of outputs, one output of the plurality of outputs of
34 the link receive interface per input switch of the plurality of
35 input switches, each output of the plurality of outputs of the
36 link receive interface coupled to the input of the input switch
37 associated with said each output of the link receive interface,
38 the link receive interface being capable of coupling channels
39 appearing on the input of the link receive interface to the
40 outputs of the link receive interface; and

41 a plurality of receivers, one receiver of the plurality of
42 receivers per input switch of the plurality of input switches,
43 each receiver of the plurality of receivers comprising an
44 input, the input of said each receiver coupled to the first
45 output of the input switch associated with said each receiver.

1 14. A multiplexer according to claim 13, wherein the
2 first switching fabric is a spatial switching fabric.

1 15. A multiplexer according to claim 13, wherein:
2 the first switching fabric is an optical spatial switching
3 fabric capable of connecting any of the inputs of the plurality
4 of inputs of the first switching fabric to any of the outputs
5 of the plurality of outputs of the first switching fabric;

6 each of the transponders of the plurality of transponders
7 comprises a fixed wavelength laser;

8 the link receive interface is a dense wavelength division
9 multiplexing fiber-optic interface coupling discrete wavelength
10 channels appearing on the input of the link receive interface
11 to the outputs of the link receive interface, one wavelength
12 channel per output of the link receive interface; and

13 the link transmit interface is a dense wavelength division
14 multiplexing interface.

1 16. A multiplexer according to claim 15, further
2 comprising a computer coupled to the first switching fabric,
3 the plurality of the input switches, and the plurality of the
4 output switches for configuring the first switching fabric, the
5 input switches, and the output switches to determine paths

6 through the multiplexer of the discrete wavelength channels
7 appearing on the input of the link receive interface and of
8 signals at the inputs of the first switching fabric.

1 17. A multiplexer comprising:

2 a first switching means comprising means for receiving a
3 plurality of channels, a plurality of means for outputting
4 channels, and means for routing channels from the means for
5 receiving to the means for outputting;

6 a plurality of transponders means, one transponder means
7 per means for outputting, each transponder means for receiving
8 a channel from the means for outputting and converting it into
9 a fixed-wavelength channel;

10 a plurality of second switching means, one second
11 switching means per transponder means, each second switching
12 means comprising a first input, a second input, and an output,
13 said each second switching means capable of switching the first
14 or the second input of said each second switching means to the
15 output of said each second switching means, the first input of
16 said each second switching means being coupled to the
17 transponder means associated with said each second switching
18 means so as to receive the converted fixed-wavelength channel

41 a link transmit interface for receiving channels appearing
42 on the outputs of the second switching means and coupling the
43 channels appearing on the outputs of the second switching means
44 to a first dense wavelength multiplexed fiber-optic link.

1 18. A multiplexer according to claim 17, further
2 comprising computer means coupled to the first switching means,
3 the plurality of the plurality of second switching means, and
4 the plurality of the third switching means for configuring the
5 first switching means, the second switching means, and the
6 third switching means to determine paths through the
7 multiplexer of the discrete wavelength channels appearing on
8 the input of the link receive interface and of channels
9 appearing at the means for receiving of the first switching
10 means.

1 19. A multiplexer comprising:
2 a first switching fabric comprising a plurality of inputs
3 and a plurality of outputs;
4 a plurality of receivers, one receiver of the plurality of
5 receivers per output of the plurality of outputs of the first
6 switching fabric, each receiver of the plurality of receivers

7 comprising an input coupled to the output of the first
8 switching fabric associated with said each receiver;

9 a plurality of input switches, one input switch of the
10 plurality of input switches per input of the plurality of
11 inputs of the first switching fabric, each input switch of the
12 plurality of input switches comprising an input, a first
13 output, and a second output, the first output of said each
14 input switch being coupled to the input of the first switching
15 fabric associated with said each input switch;

16 a link receive interface comprising an input and a
17 plurality of outputs, one output of the plurality of outputs of
18 the link receive interface per input switch of the plurality of
19 input switches, each output of the plurality of outputs of the
20 link receive interface coupled to the input of the input switch
21 associated with said each output of the link receive interface,
22 the link receive interface being capable of coupling channels
23 appearing on the input of the link receive interface to the
24 outputs of the link receive interface;

25 a plurality of output switches, one output switch of the
26 plurality of output switches per input switch of the plurality
27 of input switches, each output switch of the plurality of
28 output switches comprising a first input, a second input, and

29 an output, the second input of said each output switch being
 30 coupled to the second output of the input switch associated
 31 with said each output switch;

32 a link transmit interface comprising a plurality of inputs
 33 and an output, one input of the plurality of inputs of the link
 34 transmit interface per output switch of the plurality of output
 35 switches, each input of the plurality of inputs of the link
 36 transmit interface coupled to the output of the output switch
 37 associated with said each input of the link transmit interface,
 38 the output of the link transmit interface being capable of
 39 coupling channels appearing on the inputs of the link transmit
 40 interface to an optical transmission link.

1 20. A multiplexer according to claim 19, wherein the
 2 first switching fabric is a spatial switching fabric.

1 21. A multiplexer according to claim 19, wherein:
 2 the first switching fabric is an optical spatial switching
 3 fabric capable of connecting any of the inputs of the plurality
 4 of inputs of the first switching fabric to any of the outputs
 5 of the plurality of outputs of the first switching fabric;

6 the link receive interface is a dense wavelength division
 7 multiplexing fiber-optic interface coupling discrete wavelength

8 channels appearing on the input of the link receive interface
9 to the outputs of the link receive interface, one wavelength
10 channel per output of the link receive interface; and
11 the link transmit interface is a dense wavelength division
12 multiplexing interface.

1 22. A multiplexer according to claim 21, further
2 comprising a computer coupled to the first switching fabric,
3 the input switches, and the output switches, the computer being
4 for configuring the first switching fabric, the input switches,
5 and the output switches to control paths of the discrete
6 wavelength channels through the multiplexer.

1 23. A multiplexer comprising:

2 a first switching means comprising a plurality of means
3 for receiving wavelength channels, a plurality of means for
4 outputting channels, and means for routing channels from the
5 means for receiving to the means for outputting;

6 a plurality of wavelength channel receivers for converting
7 wavelength channels into electronic data flows, one receiver
8 per means for outputting, each receiver coupled to the means
9 for outputting associated with said each receiver;

10 a plurality of second switching means, one second
11 switching means per means for receiving, each second switching
12 means comprising an input, a first output, and a second output,
13 said each second switching means being capable of switching the
14 input of said each second switching means to the first or the
15 second output of said each second switching means, the first
16 output of said each second switching means coupled to the input
17 of the first switching means associated with said each second
18 switching means;

19 a link receive interface for receiving wavelength channels
20 from a second dense wavelength division multiplexed fiber-optic
21 link and coupling the wavelength channels received from the
22 second fiber-optic link into the inputs of the second switching
23 means, one wavelength channel received from the second fiber-
24 optic link per second switching means;

25 a plurality of third switching means, one third switching
26 means per second switching means, each third switching means
27 comprising a first input, a second input, and an output, said
28 each third switching means being capable of switching the first
29 or the second input of said each third switching means to the
30 output of said each third switching means, the second input of
31 said each third switching means being coupled to the second

32 output of the second switching means associated with said third
33 switching means; and
34 a link transmit interface for receiving wavelength
35 channels appearing on the outputs of the third switching means
36 and coupling the channels appearing on the outputs of the third
37 switching means into a first dense wavelength multiplexed
38 fiber-optic link.

1 24. A multiplexer according to claim 23, further
2 comprising a computer coupled to the first switching means, the
3 plurality of second switching means, and the plurality of third
4 switching means for configuring the first switching means, the
5 second switching means, and the third switching means to
6 control paths of the wavelength channels through the
7 multiplexer.

1 25. A multiplexer comprising:
2 a first switching fabric comprising a plurality of inputs
3 and a plurality of outputs;
4 a plurality of transponders, one transponder of the
5 plurality of transponders per output of the plurality of
6 outputs of the first switching fabric, each transponder of the
7 plurality of transponders comprising an input and an output,

8 the input of said each transponder coupled to the output of the
9 first switching fabric associated with said each transponder;

10 a plurality of output switches, one output switch of the
11 plurality of output switches per transponder of the plurality
12 of transponders, each output switch of the plurality of output
13 switches comprising a first input, a second input, and an
14 output, the first input of said each output switch being
15 coupled to the output of the transponder associated with said
16 each output switch;

17 a link transmit interface comprising a plurality of inputs
18 and an output, one input of the plurality of inputs of the link
19 transmit interface per output switch of the plurality of output
20 switches, each input of the plurality of inputs of the link
21 transmit interface coupled to the output of the output switch
22 associated with said each input of the link transmit interface,
23 the link transmit interface being capable of coupling channels
24 appearing on the inputs of the link transmit interface to the
25 output of the link transmit interface;

26 a link receive interface comprising an input and a
27 plurality of outputs, one output of the plurality of outputs of
28 the link receive interface per output switch of the plurality
29 of output switches, each output of the plurality of outputs of

30 the link receive interface coupled to the second input of the
31 output switch associated with said each output of the link
32 receive interface, the link receive interface being capable of
33 coupling channels appearing on the input of the link receive
34 interface to the outputs of the link receive interface;

35 a multiplexer bypass connection comprising a channel input
36 and a channel output;

37 a channel splitter coupled to an optical receive link, to
38 the input of the link receive interface, and to the channel
39 input of the multiplexer bypass connection, the channel
40 splitter being capable of receiving a first plurality of
41 channels and a second plurality of channels from the optical
42 receive link, transmitting the first plurality of channels to
43 the input of the link receive interface, and transmitting the
44 second plurality of channels to the multiplexer bypass
45 connection; and

46 a channel combiner coupled to an optical transmit link, to
47 the output of the link transmit interface, and to the channel
48 output of the multiplexer bypass connection, the channel
49 combiner being capable of receiving the second plurality of
50 channels from the output of the multiplexer bypass connection
51 and the channels coupled to the output of the link transmit

52 interface, and coupling the channels received by the channel
53 combiner into the optical transmit link.

1 26. A multiplexer according to claim 25, wherein:

2 the first switching fabric is an optical spatial switching
3 fabric capable of connecting any of the inputs of the plurality
4 of inputs of the first switching fabric to any of the outputs
5 of the plurality of outputs of the first switching fabric;

6 each of the transponders of the plurality of transponders
7 comprises a fixed wavelength laser;

8 the link receive interface is a dense wavelength division
9 multiplexing fiber-optic interface coupling discrete wavelength
10 channels appearing on the input of the link receive interface
11 to the outputs of the link receive interface, one wavelength
12 channel per output of the link receive interface; and

13 the link transmit interface is a dense wavelength division
14 multiplexing interface.

1 27. A multiplexer according to claim 26, further
2 comprising a computer coupled to the first switching fabric and
3 the output switches for configuring the output switches to
4 select which of the channels appearing on the input of the link
5 receive interface are coupled to the optical transmission link,

6 and for configuring the first switching fabric to select paths
7 of signals appearing at the inputs of the first switching
8 fabric through the first switching fabric.

1 28. A multiplexer according to claim 27, wherein:
2 the channel splitter comprises a circulator; and
3 the channel combiner comprises a circulator.

1 29. A multiplexer according to claim 27, wherein the
2 channel splitter comprises a wavelength filter for separating
3 the first plurality of channels from the second plurality of
4 channels.

1 30. A multiplexer comprising:
2 a first switching means comprising a plurality of means
3 for receiving channels, a plurality of means for outputting
4 channels, and means for routing channels from the means for
5 receiving to the means for outputting;
6 a plurality of transponder means, one transponder means
7 per means for outputting, each transponder means for receiving
8 a channel from the means for outputting associated with said
9 each transponder means and converting the channel received by
10 said each transponder means into a fixed-wavelength channel;

11 a plurality of second switching means, one second
 12 switching means per transponder means, each second switching
 13 means comprising a first input, a second input, and an output,
 14 said each second switching means capable of switching the first
 15 or the second input of said each second switching means to the
 16 output of said each second switching means, the first input of
 17 said each second switching means coupled to the transponder
 18 means associated with said each second switching means so as to
 19 receive the converted fixed-wavelength channel of the
 20 transponder means associated we said each second switching
 21 means;

22 a link transmit interface means comprising an output, the
 23 link transmit interface means being for receiving channels
 24 appearing on the outputs of the second switching means and
 25 coupling the channels appearing on the outputs of the second
 26 switching means into the output of the link transmit interface
 27 means;

28 a link receive interface means comprising an input for
 29 receiving dense wavelength division multiplexed channels and
 30 coupling the received wavelength division multiplexed channels
 31 into the second inputs of the plurality of second switching

32 means, one wavelength division multiplexed channel received by
33 the link receive interface means per second switching means;

34 a multiplexer bypass connection comprising a channel input
35 and a channel output;

36 a channel splitter means coupled to an optical receive
37 link, to the input of the link receive interface means, and to
38 the channel input of the multiplexer bypass connection, the
39 channel splitter means being for receiving a first plurality of
40 channels and a second plurality of channels from the optical
41 receive link, transmitting the first plurality of channels to
42 the link receive interface means, and transmitting the second
43 plurality of channels to the multiplexer bypass connection; and

44 a channel combiner means coupled to an optical transmit
45 link, to the output of the link transmit interface means, and
46 to the channel output of the multiplexer bypass connection, the
47 channel combiner being for receiving the second plurality of
48 channels from the output of the multiplexer bypass connection
49 and the channels coupled to the output of the link transmit
50 interface means, and for coupling the channels received by the
51 channel combiner means into the optical transmit link.

1 31. A multiplexer according to claim 30, further
2 comprising computer means coupled to the first switching means

3 and the plurality of second switching means for configuring the
4 plurality of second switching means to select which of the
5 channels at the inputs of the second switching means are
6 coupled to the optical transmit link, and for configuring the
7 first switching means to select paths of channels appearing at
8 the means for receiving of the first switching means through
9 the first switching means.

1 32. A multiplexer comprising:

2 a first switching fabric comprising a plurality of inputs
3 and a plurality of outputs;

4 a plurality of receivers, one receiver of the plurality of
5 receivers per output of the plurality of outputs of the first
6 switching fabric, each receiver of the plurality of receivers
7 comprising an input coupled to the output of the first
8 switching fabric associated with said each receiver;

9 a plurality of input switches, one input switch of the
10 plurality of input switches per input of the plurality of
11 inputs of the first switching fabric, each input switch of the
12 plurality of input switches comprising an input, a first
13 output, and a second output, the first output of said each
14 input switch being coupled to the input of the first switching
15 fabric associated with said each input switch;

16 a link receive interface comprising an input and a
 17 plurality of outputs, one output of the plurality of outputs of
 18 the link receive interface per input switch of the plurality of
 19 input switches, each output of the plurality of outputs of the
 20 link receive interface coupled to the input of the input switch
 21 associated with said each output of the link receive interface,
 22 the link receive interface being capable of coupling channels
 23 appearing on the input of the link receive interface to the
 24 outputs of the link receive interface;

25 a link transmit interface comprising a plurality of inputs
 26 and an output, one input of the plurality of inputs of the link
 27 transmit interface per input switch of the plurality of input
 28 switches, each input of the plurality of inputs of the link
 29 transmit interface coupled to the second output of the input
 30 switch associated with said each input of the link transmit
 31 interface, the link transmit interface being capable of
 32 coupling channels appearing on the inputs of the link transmit
 33 interface to the output of the link transmit interface;

34 a multiplexer bypass connection comprising a channel input
 35 and a channel output;

36 a channel splitter coupled to an optical receive link, to
 37 the input of the link receive interface, and to the channel

38 input of the multiplexer bypass connection, the channel
39 splitter being capable of receiving a first plurality of
40 channels and a second plurality of channels from the optical
41 receive link, transmitting the first plurality of channels to
42 the input of the link receive interface, and transmitting the
43 second plurality of channels to the multiplexer bypass
44 connection; and

45 a channel combiner coupled to an optical transmit link, to
46 the output of the link transmit interface, and to the channel
47 output of the multiplexer bypass connection, the channel
48 combiner being capable of receiving the second plurality of
49 channels from the output of the multiplexer bypass connection
50 and the channels coupled to the output of the link transmit
51 interface, and coupling the channels received by the channel
52 combiner into the optical transmit link.

1 33. A multiplexer according to claim 32, wherein:

2 the first switching fabric is an optical spatial switching
3 fabric capable of connecting any of the inputs of the plurality
4 of inputs of the first switching fabric to any of the outputs
5 of the plurality of outputs of the first switching fabric;

6 the link receive interface is a dense wavelength division
7 multiplexing fiber-optic interface coupling discrete wavelength

8 channels appearing on the input of the link receive interface
9 to the outputs of the link receive interface, one wavelength
10 channel per output of the link receive interface; and
11 the link transmit interface is a dense wavelength division
12 multiplexing interface.

1 34. A multiplexer according to claim 33, further
2 comprising a computer coupled to the first switching fabric and
3 the input switches for configuring the first switching fabric
4 and the input switches to control paths of the discrete
5 wavelength channels through the multiplexer.

1 35. A multiplexer according to claim 34, wherein:
2 the channel splitter comprises a circulator; and
3 the channel combiner comprises a circulator.

1 36. A multiplexer according to claim 34, wherein the
2 channel splitter comprises a wavelength filter for separating
3 the first plurality of channels from the second plurality of
4 channels.

1 37. A multiplexer comprising:
2 a first switching means comprising a plurality of means
3 for receiving wavelength channels, a plurality of means for

4 outputting wavelength channels, and means for routing
5 wavelength channels from the means for receiving to the means
6 for outputting;

7 a plurality of wavelength channel receivers for converting
8 wavelength channels into electronic data flows, one receiver
9 per means for outputting, each receiver coupled to the means
10 for outputting associated with said each receiver;

11 a plurality of second switching means, one second
12 switching means per means for receiving, each second switching
13 means comprising an input, a first output, and a second output,
14 said each second switching means capable of switching the input
15 of said each second switching means to the first or the second
16 output of said each second switching means, the first output of
17 said each second switching means coupled to the input of the
18 first switching means associated with said each second
19 switching means;

20 a link receive interface means comprising an input, for
21 receiving dense wavelength division multiplexed channels
22 appearing at the input of the link receive interface means and
23 coupling the received wavelength division multiplexed channels
24 into the inputs of the second switching means, one received

25 wavelength division multiplexed channel per second switching
26 means;

27 a link transmit interface means comprising an output, the
28 link transmit interface means being for receiving wavelength
29 channels appearing on the second outputs of the second
30 switching means and coupling the channels appearing on the
31 second outputs of the second switching means into the output of
32 the link transmit interface means;

33 a multiplexer bypass connection comprising a channel input
34 and a channel output;

35 a channel splitter means coupled to an optical receive
36 link, to the input of the link receive interface means, and to
37 the channel input of the multiplexer bypass connection, the
38 channel splitter means being for receiving a first plurality of
39 wavelength channels and a second plurality of wavelength
40 channels from the optical receive link, transmitting the first
41 plurality of channels to the link receive interface means, and
42 transmitting the second plurality of channels to the channel
43 input of the multiplexer bypass connection; and

44 a channel combiner means coupled to an optical transmit
45 link, to the output of the link transmit interface means, and
46 to the channel output of the multiplexer bypass connection, the

47 channel combiner being for receiving the second plurality of
48 channels from the output of the multiplexer bypass connection
49 and the channels coupled to the output of the link transmit
50 interface means, and for coupling the channels received by the
51 channel combiner means into the optical transmit link.

1 38. A multiplexer according to claim 37, further
2 comprising computer means coupled to the first switching means
3 and the plurality of second switching means for configuring the
4 first switching means and the plurality of second switching
5 means to control paths of the first plurality of wavelength
6 channels through the multiplexer.

1 39. A multiplexer comprising:

2 a first switching fabric comprising a plurality of inputs
3 and a plurality of outputs;

4 a plurality of transponders, each transponder of the
5 plurality of transponders comprising an input and an output,
6 the input of said each transponder connected to a different one
7 of the outputs of the plurality of outputs of the first
8 switching fabric;

9 a plurality of output switches comprising a first set of
10 output switches and a second set of output switches, one output

11 switch of the plurality of output switches per transponder of
12 the plurality of transponders, each output switch of the
13 plurality of output switches comprising a first input, a second
14 input, and an output, the first input of said each output
15 switch being coupled to the output of the transponder
16 associated with said each output switch;

17 a first link transmit interface comprising a plurality of
18 inputs and an output, one input of the plurality of inputs of
19 the first link transmit interface per output switch of the
20 first set of output switches, each input of the plurality of
21 inputs of the first link transmit interface coupled to the
22 output of the output switch associated with said each input of
23 the first link transmit interface, the first link transmit
24 interface being capable of coupling channels appearing on the
25 inputs of the first link transmit interface to the output of
26 the first link transmit interface;

27 a second link transmit interface comprising a plurality of
28 inputs and an output, one input of the plurality of inputs of
29 the second link transmit interface per output switch of the
30 second set of output switches, each input of the plurality of
31 inputs of the second link transmit interface coupled to the
32 output of the output switch associated with said each input of

33 the second link transmit interface, the second link transmit
34 interface being capable of coupling channels appearing on the
35 inputs of the second link transmit interface to the output of
36 the second link transmit interface;

37 a plurality of input switches comprising a first set of
38 input switches and a second set of input switches, one input
39 switch of the first set of input switches per output switch of
40 the first set of output switches, one input switch of the
41 second set of input switches per output switch of the second
42 set of output switches, each input switch of the plurality of
43 input switches comprising an input, a first output, and a
44 second output, the second output of said each input switch
45 coupled to the second input of the output switch associated
46 with said each input switch;

47 a first link receive interface comprising an input and a
48 plurality of outputs, one output of the plurality of outputs of
49 the first link receive interface per input switch of the first
50 set of input switches, each output of the plurality of outputs
51 of the first link receive interface coupled to the input of the
52 input switch associated with said each output of the first link
53 receive interface, the first link receive interface being
54 capable of coupling channels appearing on the input of the

55 first link receive interface to the outputs of the first link
 56 receive interface, one said channel appearing on the input of
 57 the first link receive interface per output of the plurality of
 58 outputs of the first link receive interface;

59 a second link receive interface comprising an input and a
 60 plurality of outputs, one output of the plurality of outputs of
 61 the second link receive interface per input switch of the
 62 second set of input switches, each output of the plurality of
 63 outputs of the second link receive interface coupled to the
 64 input of the input switch associated with said each output of
 65 the second link receive interface, the second link receive
 66 interface being capable of coupling channels appearing on the
 67 input of the second link receive interface to the outputs of
 68 the second link receive interface, one said channel appearing
 69 on the input of the second link receive interface per output of
 70 the plurality of outputs of the second link receive interface;

71 a second switching fabric comprising a plurality of inputs
 72 and a plurality of outputs, one input of the plurality of
 73 inputs of the second switching fabric per input switch of the
 74 plurality of input switches, each input of the plurality of
 75 inputs of the second switching fabric coupled to the first

11 each of the transponders of the plurality of transponders
12 comprises a fixed wavelength laser;

13 the first link receive interface is a dense wavelength
14 division multiplexing fiber-optic interface coupling discrete
15 wavelength channels appearing on the input of the first link
16 receive interface to the outputs of the first link receive
17 interface;

18 the second link receive interface is a dense wavelength
19 division multiplexing fiber-optic interface coupling discrete
20 wavelength channels appearing on the input of the second link
21 receive interface to the outputs of the second link receive
22 interface;

23 the first and the second link transmit interfaces are
24 dense wavelength division multiplexing interfaces.

1 42. A multiplexer according to claim 41, further
2 comprising a computer coupled to the first switching fabric,
3 the second switching fabric, the plurality of the input
4 switches, and the plurality of the output switches for
5 configuring the first switching fabric, the second switching
6 fabric, the input switches, and the output switches to
7 determine paths of the discrete wavelength channels appearing
8 on the inputs of the first and second link receive interfaces

9 and channels at the inputs of the first switching fabric
10 through the multiplexer.

1 43. A multiplexer according to claim 42, further
2 comprising:

3 a first multiplexer bypass connection comprising a channel
4 input and a channel output;

5 a first channel splitter coupled to a first optical
6 receive link, to the input of the first link receive interface,
7 and to the channel input of the first multiplexer bypass
8 connection, the first channel splitter capable of receiving a
9 first plurality of channels and a second plurality of channels
10 from the first optical receive link, transmitting the first
11 plurality of channels to the input of the first link receive
12 interface, and transmitting the second plurality of channels to
13 the first multiplexer bypass connection;

14 a first channel combiner coupled to a first optical
15 transmit link, to the output of the first link transmit
16 interface, and to the channel output of the first multiplexer
17 bypass connection, the first channel combiner capable of
18 receiving the second plurality of channels from the channel
19 output of the first multiplexer bypass connection and the
20 channels coupled to the output of the first link transmit

21 interface, and coupling the channels received by the first
22 channel combiner into the first optical transmit link;
23 a second multiplexer bypass connection comprising a
24 channel input and a channel output;
25 a second channel splitter coupled to a second optical
26 receive link, to the input of the second link receive
27 interface, and to the channel input of the second multiplexer
28 bypass connection, the second channel splitter being capable of
29 receiving a third plurality of channels and a fourth plurality
30 of channels from the second optical receive link, transmitting
31 the third plurality of channels to the input of the second link
32 receive interface, and transmitting the fourth plurality of
33 channels to the second multiplexer bypass connection; and
34 a second channel combiner coupled to a second optical
35 transmit link, to the output of the second link transmit
36 interface, and to the channel output of the second multiplexer
37 bypass connection, the second channel combiner being capable of
38 receiving the fourth plurality of channels from the channel
39 output of the second multiplexer bypass connection and the
40 channels coupled to the output of the second link transmit
41 interface, and coupling the channels received by the second
42 channel combiner into the second optical transmit link.

44. A method for restoring a communication path between a first input of the plurality of inputs of the first switching fabric of the multiplexer according to claim 42 and a second node, the multiplexer and the second node being connected in an optical network by a first optical fiber and a second optical fiber, wherein the first input of the multiplexer communicates with the second node through a first channel transmitted by the first link transmit interface and the first optical fiber, the method comprises:

detecting failure of a transmission path through the first optical fiber;

identifying a second channel available for communication between the multiplexer and the second node, the second node being capable of receiving the second channel, the second channel capable of being transmitted by the second link transmit interface through the second optical fiber;

configuring the first switching fabric to connect the first input of the first switching fabric associated with a first transponder of the plurality of transponders, the first transponder comprises a laser with a fixed wavelength associated with the second channel;

22 configuring the output switches to connect the output of
23 the first transponder to the second link transmit interface;
24 and
25 notifying the second node of switchover to the second
26 channel.

1 45. A method for restoring a communication path between a
2 first receiver of the plurality of receivers of the multiplexer
3 according to claim 42 and a second node, the multiplexer and
4 the second node being connected in an optical network by a
5 first optical fiber and a second optical fiber, wherein the
6 first receiver communicates with the second node through a
7 first channel transmitted by the first optical fiber and the
8 first link receive interface, the method comprises:

9 detecting failure of a transmission path through the first
10 optical fiber;

11 identifying a second channel available for communication
12 between the first receiver and the second node, the second node
13 being capable of transmitting the second channel, the second
14 channel capable of being received by the second link receive
15 interface through the second optical fiber;

16 configuring the second switching fabric and the input
17 switches to route the second channel to the first receiver; and

18 notifying the second node of switchover to the second
19 channel.

1 46. A multiplexer comprising:

2 a first switching means comprising a plurality of means
3 for receiving channels, a plurality of means for outputting
4 channels, and a means for routing channels from the means for
5 receiving of the first switching means to the means for
6 outputting of the first switching means, the plurality of the
7 means for receiving of the first switching means comprising a
8 first subset of the means for receiving of the first switching
9 means, the means for routing of the first switching means
10 comprising means for routing each channel input through the
11 first subset of the means for receiving of the first switching
12 means to at least two of the means for outputting of the first
13 switching means;

14 a plurality of transponder means, one transponder means
15 per means for outputting of the first switching means, each
16 transponder means for receiving a channel from the means for
17 outputting of the first switching means associated with said
18 each transponder means, and for converting the channel received
19 by said each transponder means into a fixed-wavelength channel;

20 a plurality of output switching means comprising a first
21 set of output switching means and a second set of output
22 switching means, one output switching means per transponder
23 means, each output switching means comprising a first input, a
24 second input, and an output, said each output switching means
25 capable of switching the first or the second input of said each
26 output switching means to the output of said each output
27 switching means, the first input of said each output switching
28 means being coupled to the transponder means associated with
29 said each output switching means for receiving the channel
30 converted by said transponder means associated with said each
31 output switching means;

32 a first link transmit interface for receiving channels
33 appearing on the outputs of the first set of output switching
34 means and coupling the channels appearing on the outputs of the
35 first set of output switching means into a first dense
36 wavelength division multiplexed fiber-optic link;

37 a second link transmit interface for receiving channels
38 appearing on the outputs of the second set of output switching
39 means and coupling the channels appearing on the outputs of the
40 second set of output switching means into a second dense
41 wavelength division multiplexed fiber-optic link;

42 a plurality of input switching means comprising a first
43 set of input switching means and a second set of input
44 switching means, one input switching means of the first set of
45 input switching means per output switching means of the first
46 set of output switching means, one input switching means of the
47 second set of input switching means per output switching means
48 of the second set of output switching means, each input
49 switching means comprising an input, a first output, and a
50 second output, said each input switching means capable of
51 switching the input of said each input switching means to the
52 first or the second output of said each input switching means,
53 the second output of said each input switching means coupled to
54 the second input of the output switching means associated with
55 said each input switching means;

56 a first link receive interface for receiving discrete
57 wavelength channels from a third dense wavelength division
58 multiplexed fiber-optic link and for coupling the channels
59 received from the third fiber-optic link into the inputs of the
60 first set of input switching means, one channel received from
61 the third fiber-optic link per input switching means of the
62 first set of input switching means;

63 a second link receive interface for receiving discrete
 64 wavelength channels from a fourth dense wavelength division
 65 multiplexed fiber-optic link and for coupling the channels
 66 received from the fourth fiber-optic link into the inputs of
 67 the second set of input switching means, one channel received
 68 from the fourth fiber-optic link per input switching means of
 69 the second set of input switching means;

70 a second switching means comprising a plurality of means
 71 for receiving channels, a plurality of means for outputting
 72 channels, and a means for routing channels from the means for
 73 receiving of the second switching means to the means for
 74 outputting of the second switching means, the plurality of the
 75 means for receiving of the second switching means comprising a
 76 second subset of the means for receiving of the second
 77 switching means, the means for routing of the second switching
 78 means comprising means for routing each channel input through
 79 the second subset of the means for receiving of the second
 80 switching means to at least two of the means for outputting of
 81 the second switching means; and

82 a plurality of wavelength channel receivers for converting
 83 wavelength channels into electronic data flows, one receiver
 84 per means for outputting of the second switching means, each

85 wavelength channel receiver coupled to the means for outputting
86 of the second switching means associated with said each
87 receiver.

1 47. A multiplexer according to claim 46, further
2 comprising computer means coupled to the first switching means,
3 the second switching means, the plurality of input switching
4 means, and the plurality of output switching means, the
5 computer means being for configuring the first switching means,
6 the second switching means, the plurality of the input
7 switching means, and the plurality of output switching means to
8 control paths through the multiplexer of the channels received
9 from the third and fourth fiber-optic links and of channels
10 received by the means for receiving of the first switching
11 means.

1 48. A multiplexer comprising:
2 a first switching fabric comprising a plurality of inputs
3 and a plurality of outputs;
4 a plurality of transponders, each transponder of the
5 plurality of transponders comprising an input and an output,
6 the input of said each transponder connected to a different one

7 of the outputs of the plurality of outputs of the first
8 switching fabric;

9 a plurality of output switches, one output switch of the
10 plurality of output switches per transponder of the plurality
11 of transponders, each output switch of the plurality of output
12 switches comprising a first input, a second input, and an
13 output, the first input of said each output switch being
14 coupled to the output of the transponder associated with said
15 each output switch;

16 a link transmit interface comprising a plurality of inputs
17 and an output, one input of the plurality of inputs of the link
18 transmit interface per output switch of the plurality of output
19 switches, each input of the plurality of inputs of the link
20 transmit interface coupled to the output of the output switch
21 associated with said each input of the link transmit interface,
22 the output of the link transmit interface coupling channels
23 appearing on the inputs of the link transmit interface to the
24 output of the link transmit interface;

25 a plurality of input switches, one input switch of the
26 plurality of input switches per output switch of the plurality
27 of output switches, each input switch of the plurality of input
28 switches comprising an input, a first output, and a second

output, the second output of said each input switch coupled to the second input of the output switch associated with said each input switch;

a link receive interface comprising an input and a plurality of outputs, one output of the plurality of outputs of the link receive interface per input switch of the plurality of input switches, each output of the plurality of outputs of the link receive interface coupled to the input of the input switch associated with said each output of the link receive interface, the link receive interface being capable of coupling channels appearing on the input of the link receive interface to the outputs of the link receive interface, one said channel appearing on the input of the link receive interface per output of the plurality of outputs of the link receive interface;

a second switching fabric comprising a plurality of inputs and a plurality of outputs, one input of the plurality of inputs of the second switching fabric per input switch of the plurality of input switches, each input of the plurality of inputs of the second switching fabric coupled to the first output of the input switch associated with said each input of the second switching fabric; and

50 a plurality of receivers, one receiver of the plurality of
51 receivers per output of the plurality of outputs of the second
52 switching fabric, each receiver of the plurality of receivers
53 comprising an input, the input of said each receiver coupled to
54 the output of the second switching fabric associated with said
55 each receiver.

1 49. A multiplexer according to claim 48, wherein the
2 first switching fabric and the second switching fabric are
3 spatial switching fabrics.

1 50. A multiplexer according to claim 48, wherein:

2 the first switching fabric is an optical spatial switching
3 fabric capable of connecting any of the inputs of the plurality
4 of inputs of the first switching fabric to any of the outputs
5 of the plurality of outputs of the first switching fabric;

6 the second switching fabric is an optical spatial
7 switching fabric capable of connecting any of the inputs of the
8 plurality of inputs of the second switching fabric to any of
9 the outputs of the plurality of outputs of the second switching
10 fabric;

11 each of the transponders of the plurality of transponders
12 comprises a fixed wavelength laser;

13 the link receive interface is a dense wavelength division
14 multiplexing fiber-optic interface;
15 the link transmit interface is a dense wavelength division
16 multiplexing interface.

1 51. A multiplexer according to claim 50, further
2 comprising a computer coupled to the first switching fabric,
3 the second switching fabric, the plurality of the input
4 switches, and the plurality of the output switches for
5 configuring the first switching fabric, the second switching
6 fabric, the input switches, and the output switches to
7 determine paths through the multiplexer of the channels
8 appearing on the input of the link receive interface and
9 channels at the inputs of the first switching fabric.

1 52. A multiplexer comprising:
2 a first switching means comprising a plurality of means
3 for receiving channels, a plurality of means for outputting
4 channels, and a means for routing channels from the means for
5 receiving of the first switching means to the means for
6 outputting of the first switching means, the plurality of the
7 means for receiving of the first switching means comprising a
8 first subset of the means for receiving of the first switching

9 means, the means for routing of the first switching means
 10 comprising means for routing each channel input through the
 11 first subset of the means for receiving of the first switching
 12 means to at least two of the means for outputting of the first
 13 switching means;

14 a plurality of transponder means, one transponder means
 15 per means for outputting of the first switching means, each
 16 transponder means for receiving a channel from the means for
 17 outputting of the first switching means associated with said
 18 each transponder means, and for converting the channel received
 19 by said each transponder means into a fixed-wavelength channel;

20 a plurality of output switching means, one output
 21 switching means per transponder means, each output switching
 22 means comprising a first input, a second input, and an output,
 23 said each output switching means being for switching channels
 24 between the first or the second input of said each output
 25 switching means and the output of said each output switching
 26 means, the first input of said each output switching means
 27 being coupled to the transponder means associated with said
 28 each output switching means for receiving the channel converted
 29 by said transponder means associated with said each output
 30 switching means;

31 a link transmit interface for receiving channels appearing
32 on the outputs of the output switching means and coupling the
33 channels appearing on the outputs of the output switching means
34 into a first dense wavelength division multiplexed fiber-optic
35 link;

36 a plurality of input switching means, one input switching
37 means per output switching means, each input switching means
38 comprising an input, a first output, and a second output, said
39 each input switching means being for switching channels between
40 the input of said each input switching means and the first and
41 the second outputs of said each input switching means, the
42 second output of said each input switching means coupled to the
43 second input of the output switching means associated with said
44 each input switching means;

45 a link receive interface for receiving discrete wavelength
46 channels from a second dense wavelength division multiplexed
47 fiber-optic link and for coupling the channels received from
48 the second fiber-optic link into the inputs of the input
49 switching means, one channel received from the second fiber-
50 optic link per input switching means;

51 a second switching means comprising a plurality of means
52 for receiving channels, a plurality of means for outputting

53 channels, and a means for routing channels from the means for
54 receiving of the second switching means to the means for
55 outputting of the second switching means, the plurality of the
56 means for receiving of the second switching means comprising a
57 second subset of the means for receiving of the second
58 switching means, the means for routing of the second switching
59 means comprising means for routing each channel input through
60 the second subset of the means for receiving of the second
61 switching means to at least two of the means for outputting of
62 the second switching means; and

63 a plurality of wavelength channel receivers for converting
64 wavelength channels into electronic data flows, one receiver
65 per means for outputting of the second switching means, each
66 wavelength channel receiver coupled to the means for outputting
67 of the second switching means associated with said each
68 receiver.

1 53. A multiplexer according to claim 52, further
2 comprising computer means coupled to the first switching means,
3 the second switching means, the plurality of input switching
4 means, and the plurality of output switching means, the
5 computer means being for configuring the first switching means,
6 the second switching means, the plurality of the input

7 switching means, and the plurality of output switching means to
8 control paths through the multiplexer of the channels received
9 from the second fiber-optic link and of channels received by
10 the means for receiving of the first switching means.